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NEWS RELEASE

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Commencement Address
by
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National Aeronautics and Space Administration
NORTHEASTERN UNIVERSITY
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"SCIENCE AND TECHNOLOGY -- KEYS TO ECONOMIC PROGRESS"

President Knowles, Distinguished Trustees and Faculty, students, friends, members of the Graduating Class of 1962.

I appreciate the opportunity to be here today.

On such an occasion my thoughts, as yours must also, run backward to the events that have brought us to this time and place, and forward to anticipate where the trends and forces that affect our lives may deposit us tomorrow.

Fifty-nine years ago, the accumulated experience of man with the principle and practice of aerodynamics, coupled through an ingenious linkage of power transfer and control with, for that time,a light-weight internal combustion engine, permitted the Wright Brothers to demonstrate powerful flight by man. The world was incredulous, and even an Edison told reporters the contraption could never have any practical value. In the following years, we in the United States stood by while the airplane was developed abroad, with the result that in

World War I we were without knowledge, technology, or productive capacity. In that war no plane of United States design or manufacture was able to fly and fight. But we did wake up and in 1915 established the forerunner of our modern governmental research and development organizations, the National Advisory Committee for Aeronautics. Based on its research, 25 years later in World War II we had a national foundation of competence in aviation that played no little part in saving the nation and the free world. But even so, we were still behind in the development of the jet engine.

To consider the problem from a different viewpoint, consider this:

It was almost 50 years from the Wright Brothers' flight until we learned to build an airplane that could fly faster than sound, at 700 miles per hour. But little more than a decade was required to go from that 700 miles an hour to 4,000 miles an hour in the X-15, and by 1959 we were reaching out beyond the earth's atmosphere with spacecraft which could travel up to 25,000 miles an hour -- fast enough to overcome the earth's gravity and speed out into the solar system, never to return.

In the related field of rocketry, despite the fact that the principle dates back more than 1,500 years, pioneers in the first half of our century encountered great skepticism and resistance. Dr. Robert Goddard, the father of the modern rocket, found little enthusiasm for his philosophy that "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow." While undergoing rapid development in the 1920's, rockets became the symbol to many of impractical ideas and grandiose schemes, and Goddard and other rocket pioneers inherited the mantle of ridicule worn by the Wrights, Langley, and the other airplane pioneers.

But the Germans and the Russians went to work to expand on Goddard's experiments and to apply his theories. The V-2's that caused consternation in London were one result. The orbiting of the first man-made satellite by the Russians in 1957 was another. We have learned the hard way that technological competence knows no national boundaries. Fruitful research and development is the issue from a joining of minds and hands with facilities and support in all nations with the foresight to do so. One year before the historic flight of John Glenn, the Russians orbited and recovered a spacecraft weighing four to five times as much as the Friendship 7. It will be 1964 before we can match this weight.

If you find the recollection of these facts startling, it is because most of us rarely stop to think of the conditions which must underly technological accomplishment, wherever it flourishes.

But what does all of this mean to you? How will it affect your lives and your careers?

Let me state it in terms you have heard before: Change, and the accelerating rate of change, will be the dominant features of your existence.

Change means different things to different people. To some it means an uncomfortable uprooting of a settled existence. To others it may mean disillusionment and despair. To still others -- and this is the group in which you can place yourselves -- it means progress and opportunity.

Just as the United States government's first venture into scientific exploration -- the Lewis and Clark expedition -- led to the opening of the West and created a new frontier for the young people of that day, so are our university, our industry, and our government activities in science and technology today opening a new frontier for our college graduates of this and the coming years.

The extent to which you and your contemporaries will benefit from this new science and technology, the extent to which you will participate in the harvest from the seeds we are sowing in space research and exploration, will depend largely upon the extent to which you prepare yourselves to take advantage of it.

You have had the opportunity, during your elementary and secondary education, and during your work at Northeastern University, particularly in its program as an urban co-operative university, to lay the groundwork for a career geared to the complex age in which you live. You have the opportunity, if you choose, to continue that education here or elsewhere and acquire the more detailed and refined knowledge which graduate education can provide, or to venture immediately into fields of business and industrial activity which will provide you with the kind of experience which will enable you to cope with a fast-paced modern world.

No one who investigates the growth in our country of engineering science and technology -- scientific research and development efforts geared to applications through engineering -- can fail to perceive their accelerating importance as an influence on the way we live.

During the first four decades of this century, research and development constituted a minor part of the stream of our national activity. During World War II, science was married to the military effort and a vast expansion of research took pace. Such new things as radar, the proximity fuse, and the atomic bomb required tremendous mental and physical exertion, and this introduced a new element to science, the requirement for large-scale, organized effort. Invention became the work of organized teams and vast laboratories.

Since the war, from this marriage has been born a giant.

In the 12 years from 1946 to 1958, more than 50 billion dollars were spent in this country for scientific research and development by the Government, by universities, and by industry. In the four years since 1958, the years of the Space Age, more than 52 billion dollars have been spent in the Nation for research and development. In 1958, the annual level of national expenditures to acquire new scientific knowledge and to apply the knowledge that had already been accumulated amounted to between six and seven billion dollars.

Today this annual level has almost tripled, to 16 to 18 billion dollars. We have reached a point where, almost without exception, everything to which the individual must adjust himself is big, or new, or fast-moving. We have the giant corporation, mass production, mass marketing, mass communication, big government, jet transportation, new materials, and scientific management of it all. We have the Mercury tracking and data acquisition network operating world-wide in real time -- a new wonder of the world.

We live in a period of scientific, technological, and engineering progress which is providing us with new knowledge new processes and new materials, at an unprecedented rate. We are witnessing a leaping technology with which men and women, human beings, are hard put to keep pace. Ideas which, a few years ago, were largely found in pulp paper fiction today form the core of scientific and technical publications. Predictions which seemed visionary and unrealistic only yesterday, are being fulfilled today at a pace which is outstripping the early hopes of the most optimistic authorities.

I recall a commencement address given at a western college in 1957, only five years ago, in which the speaker at an occasion like this quoted a timetable for space exploration which had been drafted by a leader in the aeronautics industry.

The business leader who was quoted was a man well-versed in the subject and deeply concerned with our future efforts in space. He predicted that within a dozen years -- or about 1970 -- a satellite would circle the earth and the moon.

About 1990, he went on, space science and technology would have advanced to the point of launching a space ship carrying human beings which would circle the earth for an extended period as a satellite and then return safely.

And then, reaching far into the future, he suggested that shortly after the year 2000, men might take passage on a space ship which would land on the moon and return to the earth.

These seemed dramatic and far-reaching goals at the time, but we all know how conservative they have become in the intervening five years. In fact, both the originator of the predictions, and the commencement speaker who quoted them, are acutely aware today how conservative they were.

The man who created this timetable was James S. McDonnell, president of the firm which started one year after his prediction, and in three years' time produced the Mercury spacecraft in which John Glenn and Scott Carpenter orbited the earth. These great astronauts anticipated his schedule by almost 30 years.

The commencement speaker who quoted him was myself.

I tell you this story on McDonnell and myself, about how we misled the graduating class of 1957 at the Colorado College because it illustrates so vividly the pace at which science and technology are moving in this 20th Century. Since becoming Administrator of the national civilian space effort, one year and four months ago, I have seen the fulfillment of the first two of these predictions, and find myself participating in an enterprise which will endeavor to accomplish the third -- that of a manned lunar landing, exploration, and return to earth -- within this decade. If we achieve this goal, recommended by President Kennedy and established by Congress, it again will be some 30 years in advance of the date which seemed probable as recently as five years ago.

To you who are graduating today, the geometric progression of change, of accomplishment in scientific research and technology will be the dominant feature of your lives. Unlike most of your forebears, you will never have the opportunity to become fully adjusted to the world as you know it before you have thrust upon you, or before you help to discover and develop, new ideas, new methods, and new products which will change the way you live.

We do live in a world of change, and more than any other generation, we have learned to accept it as a fact of life. This is in sharp contrast with the situation which prevailed during most of human experience.

About two thousand years before the birth of Christ, man had already invented the wheel, something unknown in nature, and the sled became the wagon. In time, hand carts became horse-drawn chariots. But after that development which greatly affected civilization, little technological progress was made until the time of George Washington.

I read recently an interesting comparison of the situation of King Solomon with that of George Washington. Both men wore homespun clothing, both illuminated their houses with oil lamps, both heated with wood, both traveled in horse-drawn vehicles.

The period of human development which lay between King Solomon and George Washington covered almost 3,000 years. That between Washington and ourselves is hardly more than 150 years, but what a contrast in human progress.

Between the time of Washington and the beginning of our own century, a similar situation prevailed. When Charles Newbold, of Philadelphia, invented the cast iron plow in 1797, and decided to devote his life and fortune to it, he died believing that his life had been wasted. Except for Thomas Jefferson, and a few of his wealthy friends, farmers would have none of the iron plow, convinced that the iron poisoned the ground, or encouraged weeds to grow.

In 1825, when the British Parliament was debating the construction of a railroad between Liverpool and Manchester, many of the Members were convinced that no one would dare to ride such a fiendish device. It was asserted that the travelers would sooner let themselves be "blown away atop a gunpowder rocket than trust themselves to such a machine" as the railroad.

One wonders what those statesmen would say of Shepard, Grissom, Carpenter, or Glenn.

With the current rapid development of the rocket, that new engine which has the capacity to deliver its power both within the earth's atmosphere and out beyond into space, the speed of the process of change on earth as well as in space will increase again. It is the modern powerful rocket which makes it possible for man to propel himself into space, to conquer the new hostile environment of the universe, to do useful work in this new environment, and to bring back new knowledge about the forces of nature and about the way nature is organized. And we already know that much that is learned can be applied here on earth to accomplish vast improvements for the benefit of mankind.

The rocket, this new and powerful engine, not only permits these useful activities but also provides the means for the delivery almost instantaneously, anywhere in the world, of weapons of mass destruction. Its availability, its versatility, the vast potentials which stem from the technologies associated with it, require that this Nation not expose its very existence to the risks of a second-best position in its use.

Fortunately, the tremendous benefits to be gained from the active prosecution of our space program, now vigorously going forward under the leadership of President Kennedy, Vice President Johnson, and the proper Departments and Agencies of the Government, are not limited to the area of national security.

Our national space program also recognizes the widespread economic, medical, and educational opportunities which are inherent in these new and powerful forces.

The success of our space program is dependent upon rapid advances in increasingly efficient use of energy; the development of new materials, metals, fabrics, and lubricants which can withstand wide ranges of temperature, vibration, radiation, and vacuum; the most advanced electronics; and the marriage of all of these with the life sciences.

All of these are the very forces underlying economic growth.

But also worthy of your attention is a new situation, so new it is little understood, related to the developments of the past decade. Today this new situation involves the radically new concept that the inventions and innovations which make the best use of the newest advances in these new physical science areas can come only from intellects which have acquired a sophisticated, complete understanding of the basic laws of nature as they have unfolded at such a rapid rate. This means a university-trained, and frequently a university-based mind.

And just ahead of us is yet another new area. This comes from the situation that the new frontiers of knowledge in the physical sciences have laid a foundation for the same type of rapid advances in the life sciences. Just ahead is a breakthrough in understanding of the life processes, just as we now understand the atomic processes.

What this means to you, to me, to all of us, is that the full development of the possibilities inherent in the application of scientific and technical advances can usher in, has the potential for, a period of economic growth that will bring a flowering of human progress, education, and culture. But because the application of this new knowledge must be more sophisticated than it has been before, the university, one of the few powerful continuing institutions in our society, which by its nature must do research and must prepare the graduate and postgraduate trained minds for this new period, must also somehow find a closer relationship with the business community. It is more important than ever to preserve and foster the concept that in our society it is the entrepreneurial mind that provides the means for the applications and realizations of these benefits. Innovation in these new industrial-university relationships can, I have no doubt, be pioneered on the science-technology-engineering frontier if the leaders of the community really desire to apply foresight to the most pressing problems of our time and participate in the development of widely shared goals.

In the past, many of our Nation's largest programs in research and development have either been of a defense or atomic nature, and therefore classified for national security reasons.

Now much of our space program, under the National Aeronautics and Space Act of 1958, is unclassified. Under this law, NASA is required to consult with the scientific community,which largely means the university community, in the design of its program and experiments, and to report not only to this scientific community, but also to the general public on the agency's activities and the results thereof. Further, the fullest measure of cooperation with other nations and with scientists from all the world is specified in this basic act of Congress that established the space policy of the Nation.

Under these circumstances, the National Aeronautics and Space Administration is not building up large classified Government laboratories, but is contracting as much as possible of its advanced research and development to qualified industrial firms, private research organizations, and to colleges and universities. Our policy is to place research contracts and grants at those universities where the scholars themselves, the consensus of the faculty, and the administration of the university are interested in having the work progress on a broad interdisciplinary basis, drawing together creative minds, knowledge, and resources from many fields such as mathematics, physics, astronomy, chemistry, economics, and medicine for widely shared participation. Under this policy, NASA research proceeds in the closest association with graduate and postgraduate education, thereby replenishing and augmenting the supply of highly qualified scientists, engineers, and technical experts.

It is an important fact to education, to industry, and indeed, to all persons and groups interested in economic, social, and political growth, that the technical fields in which most of our advanced work is done embody the very forces with which regional and community leadership are concerned.

These are the forces with which regional leadership must work for progress, improvement, and greater efficiency.

It is also true that the institutions through which citizens and regional community organizations cooperate to utilize these forces are not as yet strong and reliable. It is our hope that the policies underlying NASA's contracts and grants with universities and its contracts with industry will make for a widespread strengthening of these institutions, as well as understanding and capability for applications yielding benefits beyond the scope of the specific instruments and devices in our space programs.

These policies can, we believe, increasingly create situations within which the interdisciplinary groups working with us in the universities, if joined with other forces for progress and growth in the community, lay the base for even more rapid assimilation and use.

As you so well know in Boston, today large growing industries tend to concentrate in regions where research facilities are best. No part of the country can afford to neglect investments in advanced scientific and engineering education and in first class research facilities.

Modern industry, too, has much to gain from regional cooperation in support of the universities and associated research efforts. Industrial leaders are beginning, more and more, to look to the universities of their region for the most important resource of the age -- ideas, scientific brainpower, and advanced technological skill and experience.

It is not a question today of whether a region can already qualify -- can now offer the human and natural resources required -- for a particular industrial plant or Government facility.

The question is whether the region is creatively doing what it can to equip its citizens to serve their area and their Nation in a period when our prosperity and our very existence as a free people depend on scientific and technological leadership.

In the light of these considerations, let us turn now to New England, and the opportunities which exist for participation by Massachusetts and the New England area in our national scientific and technological effort.

It should be noted that the production of space vehicles and equipment differs greatly from the industrial mass production to which many of our industries have become accustomed. A comparison of the production of space vehicles with automotive vehicles offers an interesting contrast between the technology of the past and that of the complex scientific and technological era which we have entered.

One of our major projects in the manned exploration of space is the development and production of the Advanced Saturn first stage booster, an enormous cluster of five engines developing a total thrust of seven and one-half million pounds, weighing about five million pounds when fueled.

This first stage along with the second and third stages will comprise the Saturn C-5 booster and will be able to place more than 200,000 pounds -- 100 tons -- into earth orbit, preparatory to an expedition to the moon or for extended space flights in the vicinity of the earth.

The first stage of the Advanced Saturn will be assembled by the Boeing Company near the mouth of the Mississippi River, a strategic location in relation to the Atlantic Missile Range at Cape Canaveral, Florida, and the Marshall Space Flight Center at Huntsville, Alabama. Before the end of the decade, Boeing is scheduled to produce some 24 boosters, weighing 100 tons each, or 2,400 tons in all without fuel.

The fabrication and assembly of this 2,400 tons of exquisitely shaped tanks, pumps, valves, wire, piping, computers, gyroscopes, and ceramic components, all arranged in superbly-tested precision mechanisms, will require 50,000 tons of new construction and equipment at the Michoud plant -- more than 20 times the weight of the product which will emerge.

The Boeing Company estimates that the four or five thousand people employed in the Michoud plant will turn out only about 500 tons of product per year -- about 200 pounds per man. In contrast, an employee of the U.S. automotive industry would be responsible, as his share of over-all production, for more than 10 automobiles per year, or more than 10 tons of finished product. This is one hundred times, in weight of finished product, the production of a worker at Michoud. Furthermore, many of the components, precision parts and sub-assemblies will be shipped in from specialized suppliers all over the Nation.

While studies of the distribution of NASA procurement indicates a concentration of NASA prime contract awards among a relatively few contractors, closer examination reveals that the final destination of NASA contract dollars is far more broadly spread.

The nine largest prime contractors who in 1961 received 62 percent of NASA contracts, actually purchased or subcontracted well over half of this work to 10,989 first-tier suppliers or sub-contractors located in 46 states and the District of Columbia. One effect of this supply and sub-contract distribution was a significant geographical shift in the final location of NASA expenditures from a simple tabulation of the home-office addresses of these nine major contractors.

While 56 percent of NASA direct purchase and contract awards (for amounts of $25,000 or more) went to states west of the Mississippi, the award of sub-contracts so shifted the distribution that 53 percent of the dollars were actually spent east of the Mississippi.

Here in Massachusetts, for example, during the first half of 1961, NASA direct awards to firms and institutions totalled $4,459,000. During the second half of 1961, the amount increased to $7,297,000 -- more than 64 percent.

Figures for the first half of 1962 are not yet available, but the increase for Massachusetts is continuing. Recently we completed our source selection of the contractor team for major production of the guidance system components which the Massachusetts Institute of Technology is designing for the Apollo spacecraft.

These contracts, which initially total $20 million, went to the A.C. Spark Plug Division of General Motors, Wakefield, Massachusetts, Raytheon Company, Bedford, Massachusetts, and the Kollsman Instrument Corporation, Elmhurst, New York.

As the space program proceeds, there is every indication there will be an increasing participation by New England industries and institutions.

The Boston Federal Reserve Bank has estimated that New England manufacturers' expenditures for research and development more than doubled between 1950 and 1955, reaching $330 million in that year. By 1959 expenditures for this purpose reached $822 million, and are currently estimated at one billion dollars a year.

This increase is significant, but its effects are more so. The Bank estimates that, over a five year period, the six industries which allocated the largest amount to research and development accounted for 85 percent of the total recorded employment increases in manufacturing.

The Federal Reserve Bank also notes a phenomenon which has been duplicated throughout the country -- that one of the characteristics of a research-based economy is the ease and frequency with which large firms give birth to small ones, with young engineer-businessmen splitting off from existing companies to found new firms for making products developed from their research.

It is estimated that at least 400 new research-based industries have come into existence in the New England region since World War II, many of them through this process.

A continuing development of the relationships which already exist in New England between education and industry -- with the educational institution serving as the channel through which the results of research are transmitted to industry for practical application -- will serve this area and its citizens well in the years to come.

It is also a powerful force to create the opportunities which you graduates of Northeastern University, and your successors, seek.

An ancient Chinese philosopher, expressing his hopes for the young people of his generation, stated them with profound simplicity. He said:

"May you live in interesting times."

Certainly this is one of the assets which is yours as you remain for graduate work or leave Northeastern University to face the uncertainties, the realities, and the opportunities of life in our contemporary society. You do live in interesting times.

But more than this -- and unlike most of the descendants of that Chinese philosopher -- you have the advantage of participating in these interesting times as citizens of a great and powerful and good nation, the United States of America -- a privilege which you must not underestimate or overlook.

What being an American citizen means in an age such as this was expressed with great clarity by President Kennedy in 1960, when he wrote:

> "The American, by nature, is optimistic. He is experimental, an inventor, and a builder who builds his best when called up to build greatly. Arouse his will to believe in himself, give him a great goal to believe in, and he will create the means to reach it. This trait of American character is our greatest national asset."

On this graduation day you do have a great goal to believe in. It is the expansion and use of new knowledge to build an ever greater Nation, an ever greater Massachusetts, an ever greater New England, an ever greater family of free nations.

Congratulations and good luck.

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